Project Details	
Project Code	MRCNMH24Br Fischer
Title	Developing new therapies for compulsive behaviours by understanding the neural control of flexible action selection
Research Theme	Neuroscience & Mental Health
Summary	Compulsive behaviours (CBs) can take many forms including compulsive eating, gambling, or washing. Our project will employ a novel task to identify how neural coordination of action choices in response to CB-triggering stimuli is dysregulated. We will use electroencephalography (EEG) combined with cognitive training and neurostimulation to assess if EEG signatures of neural coordination are a viable target for developing new therapies for CBs.
Description	Compulsive behaviours can take many forms and can be triggered by multifaceted factors. To understand the neural mechanisms of behavioural dysregulation, the project will first focus on studying binge eating disorder (BED). Individuals affected by BED regularly experience out-of-control eating episodes that feel unstoppable. The diagnostic criteria include 1) eating an unusually large amount of food despite feeling full, 2) eating rapidly, and 3) marked distress about binge eating. A study published in 2022 estimated the economic burden of untreated BED in the UK to be >£3.5 billion annually due to work impairments and healthcare needs. BED has an estimated global lifetime prevalence of 2.8%/1.0% (f/m) and over two thirds of people with BED are overweight. Despite the rising numbers, current treatment strategies are limited. Only 1 in 4 people living with BED in the UK ever receive NHS treatment, and only half of those receiving cognitive behavioural therapy fully recover. The first key objective of this PhD project is to characterize whether and how neural activity involved in controlling food-related action choices is altered in people with BED. Central to the project is a novel IGNORE-REACT-STOP task that was recently developed and tested by the primary supervisor PF. The task relies on a custom-built rotational device to obtain a continuous behavioural readout, which will allow detailed analyses of electroencephalography (EEG) data to investigate how neural activity changes when facing food-related action choices. In the first year, the PhD student will organize a focus group with individuals affected by BED to refine the task design based on their feedback. One of the co-supervisors, NL, has previously developed a Go/NoGo training protocol that helped overweight people lose weight, and reduced eating disorder symptoms in those with binge eating/bulimia. However, despite meta-analyses showing that the training reduces high-calorie food intake, effects are not seen in everyone and it is still unclear what mechanisms mediate the effects. Our novel task will both allow us to distinguish between inhibitory and attentional mechanisms and is cognitively more demanding, which might be more effective in helping participants regain agency over food-related action choices. Our second objective is to train participants to flexibly switch between food-triggered action choices (ignoring food stimuli, quickly changing a response, or rapidly stopping) to track how coordination of neural activity improves as the performance improves. Previous recordings in healthy participants performing this task have shown rapid and brief neural synchronization in the 60-90 Hz 'gamma'

	range in frontal cortical areas that are linked to inhibitory control. The primary supervisor will train the PhD student to perform detailed EEG analyses to test the hypotheses that gamma synchronization is reduced in participants with BED and can be improved with training. Finally, recent studies have shown that non-invasive transcranial alternating current (tACS) stimulation can enhance motor learning and inhibitory control. Our third objective is to test the utility of gamma tACS in facilitating the training process. In summary, our series of projects will answer: 1) Whether and how neural mechanisms that control food-related action choices are altered in people with BED 2) Can our novel executive control task be used as a training tool to improve compulsive eating behaviour? Is this form of training more or less effective than conventional Go/NoGo tasks? 3) Does personalized non-invasive neurostimulation facilitate executive control training? As the project progresses, the student may decide to include people affected by a wider range of compulsive behaviours or include participants with drug-induced compulsive behaviours to test if their findings translate across diagnoses.
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